Claims

We claim,

1. A qubit system, comprising:

   a qubit;

   a control system coupled to the qubit so that the controller can apply currents and voltages to the qubit to perform operations on the qubit.

2. The system of Claim 1, wherein the control system can perform a read out operation on the qubit.

3. The system of Claim 1, wherein the control system can perform an initialization operation on the qubit.

4. The system of Claim 1, wherein the control system can entangle the quantum states of the qubit with a second qubit.

5. The system of Claim 1, wherein the qubit is a phase qubit.

6. The system of Claim 5, wherein the qubit is a permanent readout superconducting qubit.

7. The system of Claim 6, wherein the qubit includes a superconducting substrate and a mesoscopic island covering a portion of the superconducting substrate, forming a grain boundary between the superconducting substrate and the mesoscopic island.

8. The system of Claim 1, wherein the control system includes a switch coupled between the qubit and a ground.

9. The system of Claim 2, wherein the control system includes

   a switch coupling the at least one qubit to ground;

   a current source coupled to provide current to the qubit; and

   a voltmeter coupled across the qubit.

10. The system of Claim 9, wherein the switch is a single electron transistor.

11. The system of Claim 9, wherein the current source provides a current between a first critical current corresponding to a first state of the qubit and a second critical current corresponding to a second state of the qubit.

12. The system of Claim 11, wherein the voltmeter indicates the first state or the second state dependent on the voltage measured across the qubit.

13. The system of Claim 3, wherein the control system includes

a bi-directional current source coupled to provide current to the qubit;

a switch coupled to ground the qubit.

14. The system of Claim 13, wherein the bi-directional current source, when the switch is closed, provides current in a first direction to initiate a first state and provides current in a second direction to initiate a second state.

15. The system of Claim 14, wherein the current is provided for a sufficient period of time for the quantum system of the qubit to relax into the first direction or the second direction.

16. The system of Claim 14, wherein the current is ramped off to relax the quantum state of the qubit into the first direction or the second direction.

17. The system of Claim 1, wherein the control system further includes a switch coupling the qubit to another qubit, thereby entangling quantum states of the two qubits.

18. The system of Claim 8, wherein the control system includes a second switch coupled between the switch and ground, the switch being capable of coupling the qubit to another qubit to entangle the states of the qubit with the other qubit when the second switch is opened.

19. A qubit array system, comprising:

an array of qubits, the array of qubits having at least one qubit; and

a control system coupled to the array of qubits, the control system being capable of supplying voltages and currents to the qubit.

20. The system of Claim 19, wherein the control system is capable of reading out qubits of the array of qubits.

21. The system of Claim 20, wherein the control system includes

a current source coupled across the array of qubits;

an array of switches coupled between the array of qubits and ground; and

a voltmeter coupled across the array of qubits.

22. The system of Claim 20, wherein the current source can supply a current between the critical currents of a first state of a qubit in the array of qubits and a second state of the qubit.

23. The system of Claim 22, wherein the voltmeter indicates the first state or the second state based on the voltage across the array of qubits.

24. The system of Claim 22, wherein during a readout operation of a qubit in the array of qubits, the qubit is grounded through one a switch of the array of switches.

25. The system of Claim 19, wherein the control system can initialize a qubit in the array of qubits.

26. The system of Claim 25, wherein the control system includes

a bi-directional current source coupled across the qubit;

an array of switches coupled between the array of qubits and ground, a switch of the array of switches coupled between the qubit and ground; and

wherein, during an initialization step the switch is closed grounding the qubit and the current source supplies a current to initialize the qubit.

27. The system of Claim 19, wherein the control system can entangle quantum states between qubits of the array of qubits.

28. The system of Claim 27, wherein the control system includes

a switch coupled between a first qubit and a second qubit, the first qubit and the second qubit each being of the array of qubits, wherein the quantum states of the first qubit are entangled with the quantum states of the second qubit in response to the position of the switch.

29. The system of Claim 27, wherein a third switch is coupled between the array of switches and ground, wherein quantum states of qubits of the array of qubits can be entangled through switches of the array of switches when the third switch is open.

30. The system of Claim 19, wherein the array of qubits includes phase qubits.

31. The system of Claim 19, wherein the array of qubits includes permanent readout superconducting qubits.

32. A qubit system, comprising:

at least one qubit;

a means for reading out the at least one qubit.

33. The system of Claim 32, further including

a means for initializing the at least one qubit.

34. The system of Claim 33, further including

a means for entangling the quantum states of qubits of the at least one qubit.

35. A method for reading out the state of a qubit, comprising:

grounding the qubit to form a grounded qubit;

providing a current through the grounded qubit;

measuring a voltage across the grounded qubit; and

determining the state of the qubit from the voltage.

36. The method of Claim 35, wherein grounding the qubit includes closing a switch coupled between the qubit and ground.

37. The method of Claim 35, wherein providing a current through the grounded qubit includes providing a current between a first critical current corresponding to a first state of the qubit and a second critical current corresponding to a second state of the qubit, the first critical current being a lower current than the second critical current.

38. The method of Claim 37, wherein determining the state of the qubit includes setting the state to the first state if the voltage is low and setting the state to the second state if the voltage is high.

39. The method of Claim 37, wherein determining the state of the qubit includes setting the state to a first state is a time-correlated voltage pulse arrives, and setting the state to a second state if no pulse arrives.

40. A method of initializing a qubit, comprising:

grounding the qubit; and

applying a current in a selected direction across the qubit.

41. The method of Claim 40, wherein applying the current includes supplying the current for a sufficient amount of time for the state of the qubit to relax into a selected state.

42. The method of Claim 40, wherein applying the current includes supplying the current and then ramping the current to zero so that the state of the qubit relaxes into a selected state.

43. The method of Claim 40, wherein grounding the qubit includes coupling the qubit to ground through a switch.

44. A method of entangling quantum states of qubits, comprising:

coupling a first qubits to a second qubit through at least one switch.

45. The method of Claim 44, wherein coupling the qubits includes

providing a first switch coupled to the first qubit;

providing a second switch coupled to the second qubit;

coupling the first switch to the second switch so that the quantum state of the first qubit and the quantum state of the second qubit are entangled with the first switch and the second switch closed.

46. An array of qubits, comprising

a two-dimensional array of qubits having at least one row and at least one column of qubits;

a control system coupled to the two-dimensional array of qubits, the control system supplying current and voltage to qubits in the two-dimensional array of qubits.

47. The array of claim 46, further including a two-dimensional array of grounding switches, each grounding switch of the two-dimensional array of grounding switches coupling one of the two-dimensional array of qubits to ground.

48. The array of Claim 47, further including a two-dimensional array of current switches, each of the current switches in the two-dimensional array of current switches coupling one qubit of the two-dimensional array of qubits to a current.

49. The array of Claim 48, wherein the two-dimensional array of current switches and the two-dimensional array of grounding switches are coupled to control voltages by row.

50. The array of Claim 49, further including a voltmeter coupled between the current and the ground of each row.

51. The array of Claim 50, wherein during an initialization the two-dimensional array of qubits is grounded by column and a current is supplied to qubits in that column of the two-dimensional array of qubits that are being initialized.

52. The array of Claim 50, wherein during a readout procedure, the two-dimensional array of qubits is grounded by column and a current is supplied to qubits in that column of the two-dimensional array of qubits while the voltage is measured across each qubit in the column of the two-dimensional array of qubits.